Bluegill Use of Suspended and Floating Shade Structure at Four Light Levels

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Abstract

Fish are often observed under overhead cover. This study used a laboratory setting to compare bluegill Lepomis macrochirus use of floating and suspended overhead cover at four light levels. Bluegills spent significantly ($P \leq 0.05$) more time in the floating structure quadrant than the suspended quadrant at three out of four light intensities. Position of fish was not significantly different ($P > 0.05$) across light levels. I concluded that a tactile stimulus may be important to the bluegill. This could be important in making fish habitat management decisions. It may be better to add structure in contact with the water rather than suspended over it.

Introduction

It is common to see fish hovering under or near floating cover such as rafts or logs. Gooding and Magnuson (1967) observed many species of fish congregating near their free-floating raft in a study done in the Pacific Ocean. Scientific observations of this phenomenon have also been made in freshwater systems such as lakes (Helfman 1979).

Shading is often hypothesized as the primary attraction for fish using this type of cover. Helfman (1979) found large numbers of fish, mainly members of the Centrarchidae family, congregating under his experimental floats in Lake Cazenovia, New York. The highest number of fish were found on the calmest, sunniest days. The larger the float, the greater the shaded area, and the more fish the float attracted. A float made up of only an open frame held few fish (Helfman 1979).

He concluded after doing further research that the shade provided a relative visual advantage. Objects in the sunlit areas were seen by human observers in the shade under a float at more than 2.5 times the distance at which a sunlit observer could see a shaded object. This allows shaded fish to better see oncoming sunlit objects (Helfman 1981).

Many observations of fish using shade have been made in trout streams. Lewis (1969) concluded that cover was the physical factor that most influenced brown trout Salmo trutta numbers in pools of Little Prickly Pear Creek, Montana, and

that shade production was probably one of the main reasons the fish were attracted to the cover. Fausch and White (1981) said brown trout out-competed brook trout Salvelinus fontinalis for resting positions in the shade of overhead cover.

Though it appears that shade production is a primary reason for the attraction of fish to floating cover, other possible reasons have also been studied. Among these is a tactile stimulus. Haines and Butler (1969) observed the use of artificial structure by smallmouth bass Micropterus dolomieui in a stream aquarium. Clear plastic coverts that offered only a tactile stimulus and no shade were rarely used, but the addition of a similar covert that also offered shade increased use greatly. They concluded that a tactile stimulus alone was not important to the fish, but they did not discount the possibility of a tactile stimulus playing a role in cover use since their experimental design did not allow complete separation of the two effects. Helfman (1979) concluded that a tactile stimulus was not important since fish often hover under docks and overhanging vegetation that do not touch the water, though this observation does not provide experimental support to his conclusion because no floating cover may be present as an alternative.

The importance of the thigmatic stimulus of floating cover and the effect of light intensity is unknown. In order to separate and test these variables, a more controlled study

is required.

Bluegill Lepomis macrochirus use of shade has been established (personal communication with Andrew McCartt). However, relative importance of an added thigmatic aspect of the shade had not been tested for bluegill. Is choice of a shaded area influenced by whether the bluegills can touch the object, or is presence of shade without the thigmatic element equally attractive? The objective of this study was to compare time spent by bluegills under suspended versus floating shade structures at four light levels.

Methods

Bluegills were chosen as the experimental animal because they have been used in much of the prior cover research and they are easy to capture and hold for experimentation. One hundred and twenty bluegills (Mean Total Length (TL)=48 mm, Range=31-72 mm) from Alum Creek Reservoir in central Ohio were used in the experiment. They were held in an aerated tank away from human activity and fed tubifex worms and commercial fish food every third day (McCartt 1987).

The experiment was done in a 3.7 m diameter, 0.9 m deep pool located in an isolated room to limit outside light and noise. The pool was filled with tap water to a depth of 0.75 m and allowed 2 days to dechlorinate. The light was provided by twelve 150-watt floodlight bulbs which were hung about 0.7 m above the surface of the water and arranged to obtain equal

light intensities at all points on the water surface. A Spectromatic photometer was used to find the desired light intensity settings on a rheostat. The four light intensities used were 1.5 lx (the lowest light intensity that the fish could be observed), 85 lx, 169 lx, and 340 lx (McCartt 1987).

The floating and suspended structures were a size equal to about one quadrant of the pool and constructed of 2.5 cm thick styrofoam (McCartt 1987). The suspended structure was hung to a position 1 cm above the water surface to minimize light intensity differences under the two structures, and the floating structure was secured on top of the water in the quadrant across from the suspended structure. Measurements with the Spectromatic photometer found that the light intensity on the bottom of the pool directly under the two structures was the same for both at each of the four light intensities.

Fifteen fish were chosen randomly and placed in the pool for 24 hours to acclimate to the pool and the experimental light changes which appear in Table 1 (similar to McCartt 1987). During day two, the fish positions and behavior were observed and recorded for the end 15 minutes (at 5 minute intervals) of periods 1-4, while the light intensity was raised during the beginning 15 minutes with 30 minutes for acclimation each period (McCartt 1987). During periods 5-8, the positions and behavior were observed and recorded for the

beginning 15 minutes of each period, and the light intensity was lowered in the next 15 minutes with the next 30 minutes for acclimation (McCartt 1987). After period 8 was over, the fish were removed and the two structures were each moved one quadrant to the right.

Table 1. Observation period and light change schedule (based on McCartt 1987).

Observation period	Time of day	Light intensity (lx)
1	0730-0830	1.5
2	0830-0930	85
3	0930-1030	169
4	1030-1130	340
5	1300-1400	340
6	1400-1500	169
7	1500-1600	85
8	1600-1700	1.5

The next morning at 0730 hours 15 different fish were added and the 2 day procedure repeated. No fish were fed while in the pool to limit behavior bias (McCartt 1987). The 2 day procedure was repeated for a total of eight groups of fish. The pool was emptied and cleaned after the sixth group (McCartt 1987).

The positions of the fish during each of the four different light intensities were compared in order to find any similarities in position. The morning and afternoon (increasing and decreasing light intensity) fish positions were also compared for each light level. Bartlett's Test for Homogenity was used. A transformation was done on the fraction of fish in a given quadrant at each light level. The arcsin of the square root of these numbers was taken. This increased the homogenity of the data. Analysis of Variance (ANOVA) was used to find if any variance existed. Tukey's Multiple Comparison Test was used in testing the variances at a significance level of 0.05.

Results

Bluegill use of the floating shade quadrant was significantly higher ($P \leq 0.05$) than the suspended shade quadrant at three out of the four light levels (Figure 1). At 1.5 lx, fish use of the suspended shade quadrant was significantly higher ($P \leq 0.05$) than the second open quadrant, but not the first ($P > 0.05$). Use of the floating shade quadrant was significantly higher ($P \leq 0.05$) than both of the open quadrants, but not significantly higher ($P > 0.05$) than the suspended shade quadrant. Use of the two open quadrants was not significantly different ($P > 0.05$).

At 85 lx, use of the floating shade quadrant was significantly higher ($P \leq 0.05$) than use of each of the other

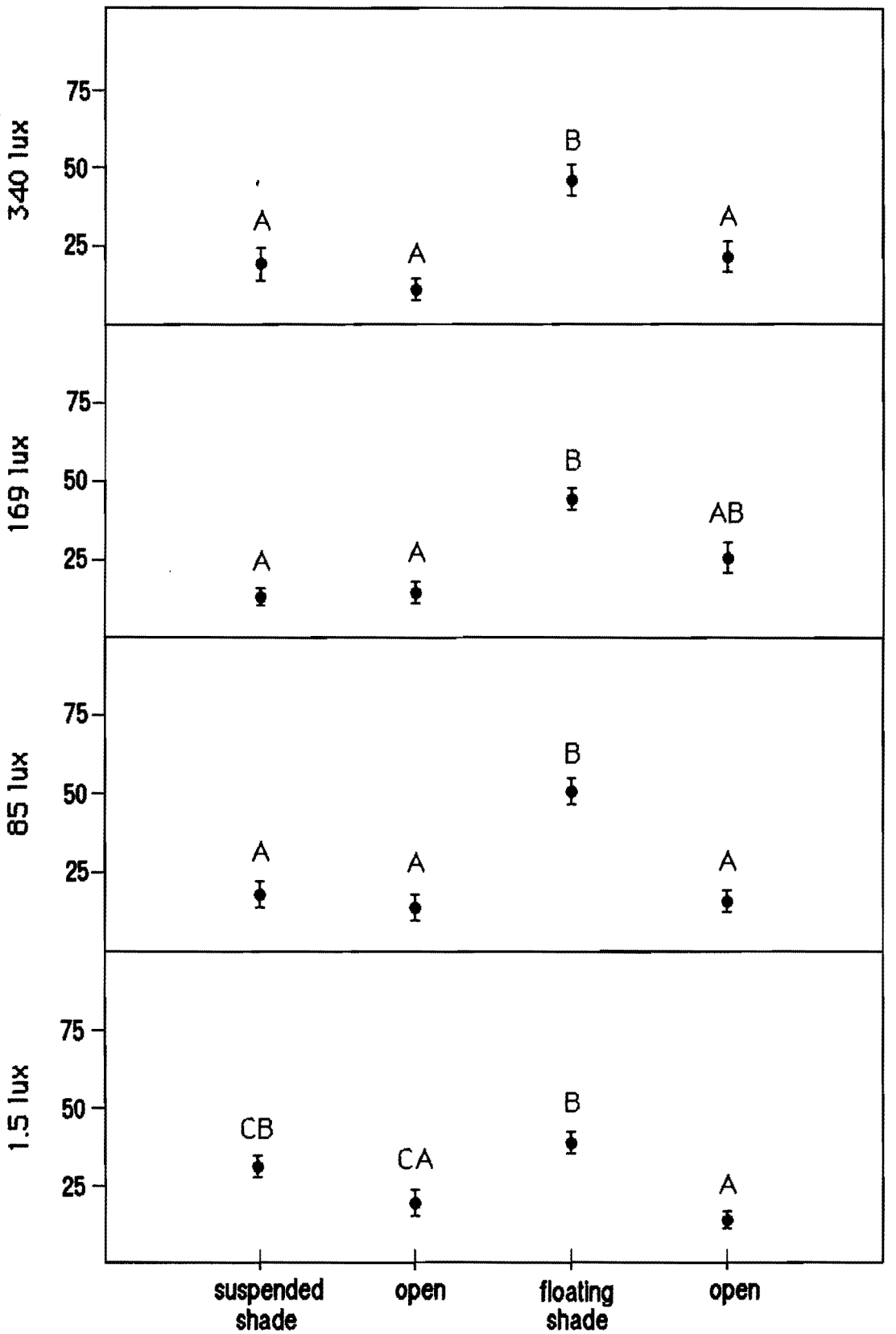

Figure 1. Mean percent of fish in each quadrant for each light intensity ± 2 SE. This data is the untransformed numbers.

three quadrants. Use of these other quadrants was not significantly different ($P>0.05$).

At 169 lx, use of the floating shade quadrant was significantly higher ($P\leq0.05$) than use of either the suspended shade or first open quadrant. Use of the floating shade quadrant and the second open quadrant was not significantly different ($P>0.05$). Use of the two open quadrants and the suspended shade quadrant was not significantly different ($P>0.05$).

At 340 lx, use of the floating shade quadrant was significantly higher ($P\leq0.05$) than use of any of the other three quadrants. Use of the other three quadrants was not significantly different ($P>0.05$).

No significant differences ($P>0.05$) occurred in fish use of a given quadrant at each of the four light intensities. For example, use of the suspended shade quadrant at each of the four light intensities was not significantly different. Also, there were no significant differences ($P>0.05$) in fish positions at each light level under morning and afternoon (increasing and decreasing) light intensities.

Discussion

Bluegill use of the two open quadrants not being found to be significantly different at any of the light intensities shows that they were both equally attractive to the fish. This was expected since both were bordered on one side by the

suspended structure and on the other by the floating structure, and the light intensity was equal at all points on the surface of the pool.

Since bluegill use of the floating shade quadrant was significantly higher than use of the suspended shade quadrant at all but the lowest light level, it can be concluded that something different about the floating shade quadrant made it more attractive to the bluegills. Though it could have been that the light intensity was lower under the floating shade structure, which would mean increased shade production, measurement with a Spectromatic photometer found that the light intensity was the same at the bottom of the pool under the two structures at each light level. The only other rational possibility for the bluegills preferring the floating shade quadrant over the suspended shade quadrant is that the floating shade structure provided a tactile stimulus. Salmonids have been shown to prefer cover with an added tactile element (Devore and White 1978), but Centrarchid increased use of cover because of an added tactile element has not been recorded. Helfman (1979) concluded that a tactile stimulus was not involved in fish use of his floating cover because of fish often observed under docks and overhanging vegetation that do not touch the water, but this is not scientific evidence since an alternative shade structure which touches the water may not be present.

Haines and Butler (1969) concluded that a tactile stimulus may be involved in yearling smallmouth bass use of shelter when other possible physical characteristics of a shelter are also present. The result in my study that the bluegill use of the floating shade quadrant was not significantly higher at the lowest light level may be related to this since at a light intensity of 1.5 lx, shade production may not be as important to the fish, and thus neither would a tactile stimulus. Though the bluegills, no matter what quadrant they were in, were usually high in the water column, they were often suspended with their dorsal sides touching the top of the floating structure when in this quadrant. This further supports the hypothesis of a tactile stimulus playing a part in bluegill use of floating cover.

I conclude that a tactile stimulus is important to bluegills, though I am unable to conclude whether shade production is necessary for it to be important. This would be a difficult study to carry out since even a piece of glass secured on the surface of the water would reduce the light intensity under it, and thus produce shade.

McCartt (1988) in using the same equipment that I did, except that he only used a suspended structure, found that as light intensity increased, bluegill use of the shaded quadrant increased. My results did not show any significant correlation between light intensity and fish position. I am still convinced that fish use of overhead cover is partly due

to shade production because the sum of the mean number of fish under the two structures was greater than the sum of the means for the two open quadrants at all four light intensities. A possible explanation is that having two shade producing structures in the pool may have produced too much light intensity reduction in the open quadrants, and thus the light intensity differences between the open and structure quadrants was not as great as it would have been if only one structure was used. The shadows of the two structures were apparent on the bottoms of the open quadrants.

Many bluegills were observed suspended just inside the outer edges of the structures facing outward. This provides support to Helfman's (1981) theory of the reduced light intensity providing the fish a relative visual advantage.

Since no significant difference in fish position was found with each light level when the light intensity was increasing or decreasing, it can be concluded that bluegills are equally attracted to overhead cover in morning and afternoon.

Overall, the main conclusion is that bluegills appear to prefer floating cover over suspended cover because of the tactile element. I feel that it would be beneficial to bluegills and possibly other species to place shade structure on the water instead of over it when feasible. The structures placed on the water may also provide a substrate for food to grow on. Helfman (1979) found that bluegills,

when associated with the floats, fed on organisms on the surfaces of the floats and in the water column.

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